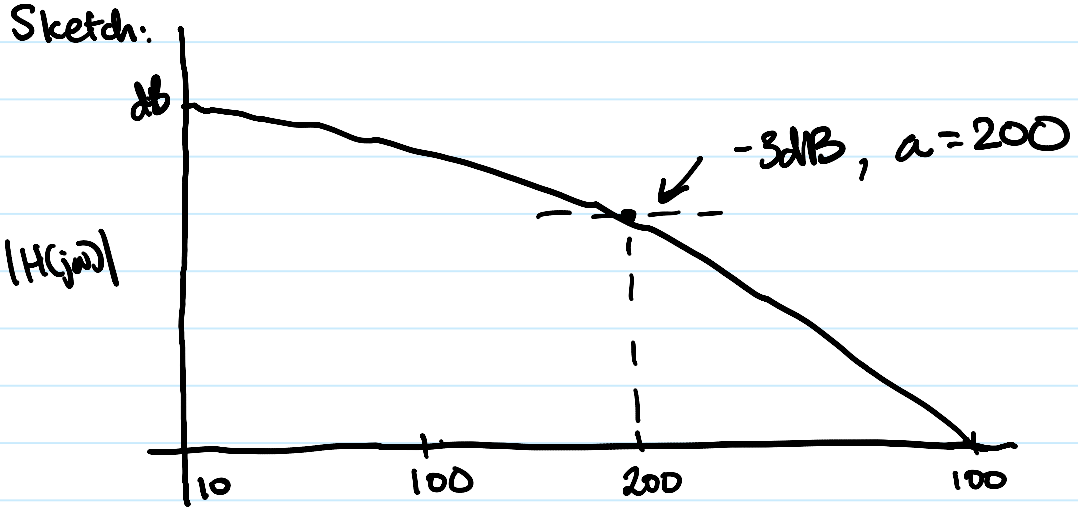
Pre-lab

Sunday, December 6, 2020 5:59 PM

1a. $H(j\omega) = \frac{a}{a+j\omega}$

$$|H(j\omega)| = 20\log\left(\frac{200}{\sqrt{200^2+\omega^2}}\right) dB$$

Sketch:



ii) low-pass filter

iii) $a = [1, 200]$ $b = [200]$

b) $x_1(t) = \cos(100t)$ $\omega = 100$

Input is in the pass-band

$$y_1(t) = |H(j\omega)| \cos(100t + \text{angle}(H(j\omega)))$$

$$H(j\omega) = \frac{200}{j\omega+200}\left(\frac{j\omega-200}{j\omega-200}\right) = |0.8-0.4j| = 0.8944$$

$$\text{angle} = \tan^{-1}\left(\frac{-0.4}{0.8}\right) = -26.58^\circ$$

$$y_1(t) = 0.894\cos(100t - 26.58)$$

$y_1(t) = 0.844 \cos(100t - 0.35)$

c) time vector = 200

$\frac{1}{5}(500) = 2000$

2a) $y(t) = x(t)\cos(200t)$

$Y(j\omega) = \frac{1}{2\pi}\left[X(j\omega) * \left(\frac{1}{2}\delta(\omega-200) + \frac{1}{2}\delta(\omega+200)\right)\right]$

$= \frac{1}{4\pi}\left[X(j(\omega-200)) + X(j(\omega+200))\right]$

Sketch:

carrier freq: $\omega_c = 200 \text{ rad/s}$

b. $\omega_c = 50 \text{ rad/s}$ for $X(j\omega)$

$\Rightarrow$ smallest carrier freq is $\omega = 50 \text{ rad/s}$

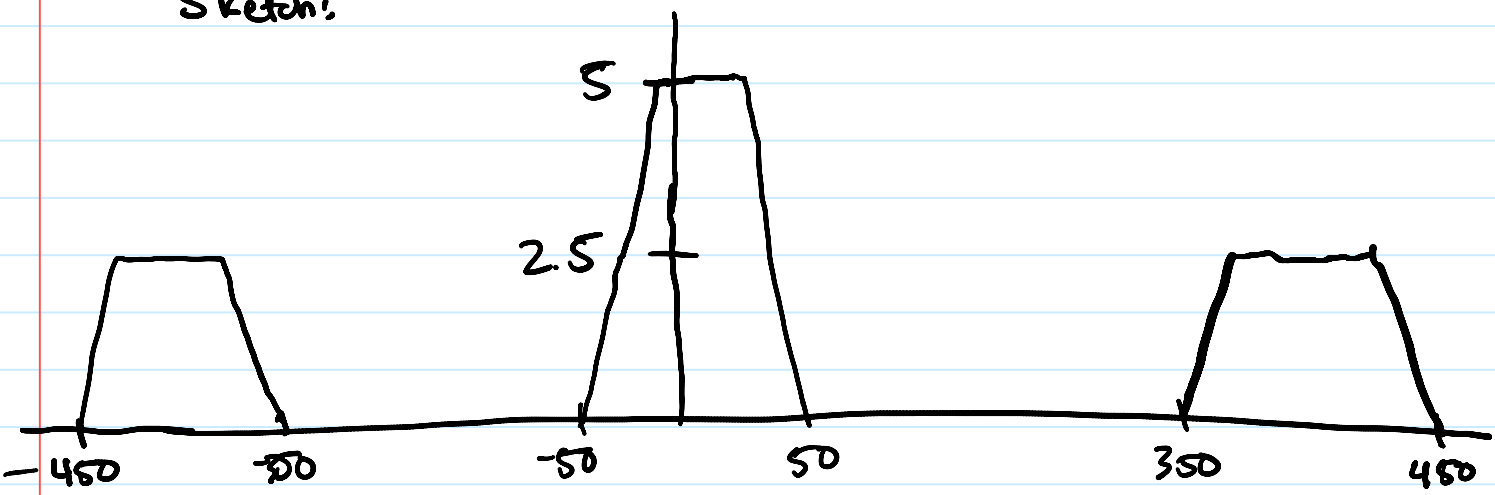
3a. $y(t) = x(t)\cos(200t)$

$z(t) = y(t)\cos(200t) = x(t)\cos^2(200t)$

$z(t) = \frac{1}{2}x(t)(1 + \cos(400t))$

$= \frac{1}{2}X(j\omega) + \frac{1}{4}\left(X(\omega-400) + X(\omega+400)\right)$

Sketch:



b $\frac{X_1(t)}{2(t)} = \frac{2E4}{\text{given eqn.}}$

i. $H(j\omega) = \frac{X(j\omega)}{2(j\omega)}$

$$= \frac{2 \cdot 10^4}{(240)(j\omega)^4 + 3E{-}4(j\omega)^3 + 2.2E6(j\omega)^2 + 10^8 j\omega + 2E4}$$

ii. a = [240, 3E-4, 2.2E6, 1E8, 2E4]

b = [2E4]

iii. $H(j0) = \frac{2E4}{2E4} = 1$

4a. $X_{dash}(t) = 50te^{-15t}u(t)$, $x_{dot}(t) = -X_{dash}(t)$

$$X_{dash}(j\omega) = \frac{50}{(15 + j\omega)^2}$$

bandwidth $= \frac{1}{\sqrt{2}} |X_{dash}(j\omega)|$

$w_c = 200$ will not allow bandwidth to work

I would decrease the exponent value to a lower rate.

b.
```
Xm = np.concatenate([dash, dot, dot, dash])
t = np.arrange(0, len(Xm), 1)
Xm = Xm*t
```

c.
```
list_errors = []
rs = received_signal
for time_slot in range(len(time_slots)):
    list_errors.append((Xm - rs)**2)
error_sum = np.sum(list_errors)
```

5a. $m_1(t)$ have $\cos(100t) \rightarrow f = \frac{50}{\pi}$ Hz

$m_2(t)$ have $\cos(200t) \rightarrow f = \frac{100}{\pi}$ Hz

$m_3(t)$ have $\cos(300t) \rightarrow f = \frac{150}{\pi}$ Hz

b.
```
length = x.shape[0] /4
check = {2: false, 3: false, 4: false}
check_point = np.sum(x[0: length]) /10
if np.sum(x[length : 2-length]) < check_point:
    check[2] = true
if np.sum(x[2-length : 3-length) < check_point:
    check[3] = true
if np.sum(x[3-length : 4-length) < check_point:
    check[4] = true
```